

RD-A187 786

COUNTER-BALANCED PENDULUM(U) AIR FORCE WRIGHT

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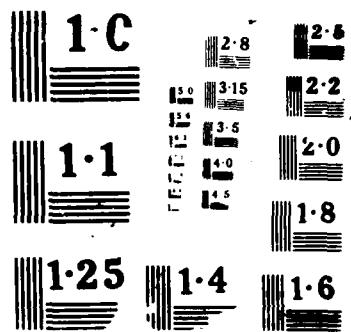
AERONAUTICAL LABS WRIGHT-PATTERSON AFB OH J LEE MAY 86

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AFWAL-TR-86-3014

COUNTER-BALANCED PENDULUM

Jon Lee

Structural Vibration Branch  
Structures and Dynamics Division

AD-A187 706

May 1986

Final Report for Period December 1985 - January 1986

Approved for public release; distribution is unlimited.

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FLIGHT DYNAMICS LABORATORY  
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES  
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WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6553

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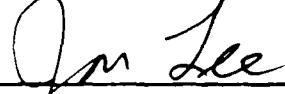
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NOTICE

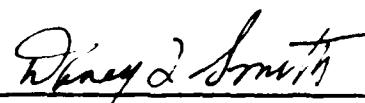
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This report has been reviewed by the Office of Public Affairs (ASD/PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.



JON LEE  
Project Engineer



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FOR THE COMMANDER



ROGER J. HEGSTROM, Colonel, USAF  
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16. SUPPLEMENTARY NOTATION This TR diskette is runnable on a Z-100 desktop computer.	17. DDCIATI CODES FIELD GROUP SUB. GR 20 11				
18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Counterbalanced pendulum, Zero g simulation, Time-integration, on Z-100 microcomputer.					
19. ABSTRACT (Continue on reverse if necessary and identify by block number) To simulate zero-gravity in ground-testing, one may analyze a system of counter-balanced pendulums made up of two identical bobs which are tied to the ends of an inextensible string and are suspended from two pulleys separated by a certain distance. With this diskette you will explore the dynamics of counter-balanced pendulums when only one bob is swung, while the other is allowed to move vertically. There are two basic modules. One is the in-situ integration by the fourth-order Runge-Kutta scheme with a tolerance check. Although there is a restriction on the choice of initial angles, you may integrate the motion as long as you please. The other module is a theoretical analysis for small and large times to deduce qualitative dynamical behavior. We have discovered an asymptotic invariant of motion which is defined analogous to the action of standard pendulum.					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS <input type="checkbox"/>	21. ABSTRACT SECURITY CLASSIFICATION Unclassified				
22a. NAME OF RESPONSIBLE INDIVIDUAL Jon Lee	22b. TELEPHONE NUMBER (Include Area Code) (513) 255-5220	22c. OFFICE SYMBOL AFWAL/FIBG			

## FOREWORD

This diskette was prepared in the Structural Vibration Branch, Structures & Dynamics Division, Flight Dynamics Laboratory, AF Wright Aeronautical Laboratories, Wright-Patterson AFB, OH 45433. The work reported herein was performed under the work unit 2304N113, Nonlinear Dynamics, during the period of December 1985 to January 1986.

To the best of our knowledge, the presentation of a TR in the form of software that one can run on a Z-100 desktop computer has never been attempted. Although a TR is traditionally a standard 8-1/2x11 printed document, we believe this way of communicating technical information is more effective because the reader can

- (1) observe the actual evolution of dynamical processes,
- (2) choose the initial data and time-range of interest,
- (3) and visualize dynamics better through animation than by words.

The author wishes to thank Dansen Brown, Lt Bob Canfield, and Arnel Pacia (Chairman) for their conscientious review of this diskette.

Direct request for TR disk to:

Jon Lee, AFWAL/FIBG,  
Wright-Patterson AFB, OH 45433.  
Tel: (513) 255-5229.

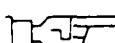
## HOW TO START

If you see two disk drives in front of the Z-100 desktop computer, then follow the procedure A. On the other hand, if you see only one disk drive, you probably have the Winchester disk system, so follow the procedure B.

### Procedure A:

- (1) Insert the TR disk into the top drive (A drive).
- (2) Turn on the power switch (on the back).
- (3) After 30 seconds of the disk access light glowing and whirring, you will be presented with the screen like Figure 1.
- (4) Proceed at your own pace by responding to the prompt Press any key to continue. You will always return to the main menu (Figure 2).

### Procedure B:

- (1) Insert the TR disk into the disk drive.
- (2) Turn on the power switch (on the back).
- (3) Press the [CTRL] and [RESET] keys simultaneously. Then, immediately, press the [DELETE] key, while the disk access light is still glowing. The screen will then display;  
Boot Abort  

- (4) Press the [B] key. The screen will display;  
Boot
- (5) Then press [F1] key and [RETURN].
- (6) After 30 seconds of the disk access light glowing and whirring, you will be presented with the screen like Figure 1.
- (7) Proceed at your own pace by responding to the prompt Press any key to continue. You will always return to the main menu (Figure 2).

AFWAL TR 86-3014 presents ...

COUNTER = B ALANCED P ENDULUM

by Jon Lee

press any key to continue

Figure 1. Congratulations! You have correctly entered into the program disk. Proceed at your own pace by responding to the prompt "press any key to continue".

*****	*****
*           Table of Contents	*
*           *	*
* (0)    Foreword	*
* (1)    Abstract	*
* (2)    Introduction	*
* (3)    Problem Statement	*
* (4)    Demo Run for Initial Angle =.3 (3 min)	*
* (5)    Do Your Own Integration (3 min and up)	*
* (6)    Theoretical Analyses (6 min)	*
* (7)    Conclusions	*
* (8)    References	*
* (9)    Enough is Enough -- Quit	-   *
*****	*****

Enter a number (0,1,...,9) to proceed;  
or <BACKSPACE>-key to cancel.

Figure 2. This is the main menu in the form of Table of Contents.  
Note the run time estimates when applicable. Allow about 15 minutes  
for a casual viewing of the entire TR disk.

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